Early Journal Content on JSTOR, Free to Anyone in the World

This article is one of nearly 500,000 scholarly works digitized and made freely available to everyone in the world by JSTOR.

Known as the Early Journal Content, this set of works include research articles, news, letters, and other writings published in more than 200 of the oldest leading academic journals. The works date from the mid-seventeenth to the early twentieth centuries.

We encourage people to read and share the Early Journal Content openly and to tell others that this resource exists. People may post this content online or redistribute in any way for non-commercial purposes.

Read more about Early Journal Content at http://about.jstor.org/participate-jstor/individuals/early-journal-content.

JSTOR is a digital library of academic journals, books, and primary source objects. JSTOR helps people discover, use, and build upon a wide range of content through a powerful research and teaching platform, and preserves this content for future generations. JSTOR is part of ITHAKA, a not-for-profit organization that also includes Ithaka S+R and Portico. For more information about JSTOR, please contact support@jstor.org.

XX.

CONTRIBUTIONS FROM THE JEFFERSON PHYSICAL LABORATORY.

PHOTOGRAPHY OF THE LEAST REFRANGIBLE PORTION OF THE SOLAR SPECTRUM.

By J. C. B. Burbank.

Presented by Professor Trowbridge, March 14, 1888.

It has been stated by eminent authorities, that the process of staining dry plates with various dyes is not applicable to the photography of the invisible rays beyond the red of the solar spectrum. To test this question I have undertaken a series of experiments with the dye cyanine. This dye has of late come into considerable prominence in photography, owing to its orthochromatic effect when mixed with other dyes, such as chinoline-red, azaline, erythrosine, and eosine.

It was discovered by Greville Williams, an Englishman, in 1861, but did not come into much prominence until the year 1884, when its usefulness as a sensitizer became more apparent. The dye is easily decomposed by light, and even in the dark both its solution and the plates coated with it are apt to become decomposed if kept for any length of time. Alone, it has been found very useful to sensitize plates for the orange and red portions of the spectrum. No experiments have to my knowledge been made upon the effect of heat rays upon cyanine plates.

The direct action of absorbents in the infra red has not, hitherto, been tried with any success; moreover, it has been stated by so eminent an authority as Captain W. De W. Abney that it was impossible to make plates sensitive to any rays below the A of the solar spectrum by means of the addition of dyes to a film. It is true, however, that Major Waterhouse has succeeded by means of turmeric in obtaining evidence of the existence of a few lines on the less refrangible side of A, but in all cases except one these were reversed.

The plates employed were made by the M. A. Seed Co. of sensitometer 22. The method used in staining the plates and in the preparation of the dye is substantially the same as that employed by J. B B. Wellington,* and is as follows.

Fifteen grains of cyanine are gently heated (over a steam bath) for from thirty to forty minutes in combination with 1 oz. of chloral hydrate and 4 oz. of water. The whole mixture should now be stirred vigorously. While this operation is going on, 120 grains of sulphate of quinine are dissolved by heat in a few ounces of methylated spirit. (If methylated spirit cannot be obtained, a solution of 90% alcohol and 10% wood spirits will answer perfectly well.) One ounce of strong aqua ammonia is now slowly added to the cyanine mixture above. Violent ebullition takes place immediately, chloroform being evolved, and cyanine is deposited in a soluble form on the sides of the vessel. The mixture is allowed to settle for a few minutes, and then the supernatant liquid is decanted off very slowly, care being taken not to detach any of the cyanine that is formed on the sides.

To the remaining cyanine, three or four ounces of methylated spirit are added to dissolve the cyanine; the quinine solution is then added; and to the whole more methylated spirit, until the whole mixture measures from eight to nine ounces. This solution constitutes the "stock" solution, and should be kept away from all light, as it is very apt to become decomposed.

All of the above operations should be conducted in as little light as possible. The following staining and drying processes should be conducted in absolute darkness.

To thirty ounces of water are added 1½ drachms of the cyanine stock solution; the graduate that contained the cyanine is now washed out, 1½ drachms of strong aqua ammonia are added, and the whole mixture is stirred vigorously. Into this bath two or three plates, or half a dozen strips, can be dipped at once. They should be left there about four minutes; meanwhile the tray containing the plates should be rocked continuously, so as to insure a uniform action of the dye.

This bath, after having been used once, should be thrown away, as the action on a second batch of plates would be weak and imperfect. The plates can now be drained, dried, and used. While developing, I was careful to exclude all light whatever, although I think it possible that the plates may be developed safely in a dark greenish yellow light. The developer used was a pyro. and potash developer of (generally) normal strength.

---

* See Anthony Photographic Bulletin, December 24, 1887.

In the first experiments the spectrum was produced by a Rowland flat diffraction grating, mounted on a spectrometer circle. This grating contained 17,000 lines to the inch. The observing telescope of the spectroscope was replaced by a camera and lens.

Certain photographs were also taken by means of a Rowland concave grating of 14,500 lines to the inch, and of 21 ft. 6 in. radius of curvature. With this grating, the amount of light being less and the dispersion greater than in the former cases, the exposure had to be increased.

In all of the experiments ruby-red glass screens were used in order to cut out all of the more refrangible part of the underlying spectrum. In some cases a weak solution of iodine in carbon disulphide was used with good effect.

No difficulty was found in photographing from the A line to wave-length 9900, or to the limit assigned by Abney as the limit of the diffraction spectrum. None of the lines were reversed. A special study of the A group was made, photographs being taken at different seasons in order to see if any changes in the remarkable group of lines constituting the A group could be noticed. No existing map represents this group correctly. Employing the second spectrum produced by a concave grating, 52 lines were observed between wave-lengths 7100 and 8000. In the same space Abney records only 24 lines. Between the head of A and the tail of A, the latter being the single line before the series of doublets begin which is so characteristic of the A group, my photographs show 17 lines. These photographs were taken in June between ten and one o'clock.

These results are of special interest when we consider that Abney has said in a Bakerian lecture, "As a result of these experiments I can confidently state that in no case did the addition of a dye cause any chemical effect to be produced by the rays below A of the solar spectrum, nor has Vogel claimed that they do."

It is interesting to note that Abney is led to believe that the photographic action, which has been noticed hitherto, by the use of dyes as sensitives, can be attributed to a certain action of nitrate of silver on organic matter. This effect is a bleaching one, and only the more fugitive dyes can produce it. We are led to conclude from Abney's paper, that he believes that only a chemical effect produced in a specially prepared emulsion can be used to reproduce the infra red rays. After many experiments he succeeded in producing such an emulsion. The color of this verged upon the blue. Since the color of plates stained with cyanine by the process I have described is also blue, there may be some physical significance in this resemblance.

My experiments show that a specially prepared emulsion is not necessary for the photography of the infra red region. The chemical theory advanced by Abney, therefore, seems to need revision.